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**IDENTIFIERS** \*Interactive Video

## ABSTRACT

This guide is intended to provide a prospective user of interactive video instruction with a guide to the establishment and operation of an electronics worksite training program. The training program is designed to provide beginning electronics technician training equivalent to that available at most community colleges and technical schools. The instructional program is based on an interactive video electronics course developed at the College of San Mateo. The course is self-paced and computer-based, facilitating open entry/open exit, individualized, and flexible training. The guide provides information on how instructional strategies based on the use of interactive video materials work, what equipment is needed, and how to establish and maintain a worksite training program. The guide also describes the course components and program operations. Further information on the program as developed by the Wisconsin Foundation for Vocational, Technical and Adult Education, Inc. is provided in the appendix to the guide. (KC)

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## INTRODUCTION

The purpose of this guide is to provide a prospective user of interactive - video instruction with a guide to the establishment and operation of an Electronics Worksite Training Program. The training program is designed to provide beginning electronics technician training equivalent to that available at most community colleges and technical schools.

The instructional program is based on an interactive-video, dc electronics course developed at the College of San Mateo. The course is a self-paced and computer-based, facilitating open-entry/open-exit, individualized, and flexible training.

The need for alternative and non-traditional instructional delivery strategies has been growing. A greater percentage of the workforce, because of non-traditional work schedules, geographic isolation, and family responsibilities are not able to enroll in on-campus courses.

However, providing technical training at a company site or worksite is not just a matter of cloning on-campus courses nor will the introduction of computer-assisted-instruction (CAI) in itself produce a effective training strategy. The major obstacle to worksite training is the incorporation of laboratory activities into the course structure. In total, a complete course should contain the theory, skill development, laboratory, and evaluation instructional components as well as a record keeping system to facilitate management of the instructional process.

A solution to this dilemma has emerged out of the marriage of two maturing technologies -- computer technology with the emergence of low-cost microcomputer systems and videotape technology in the form of reliable videotape players capable of being interfaced to microcomputer systems. By marrying the microcomputer to the videotape player, not only are conventional CAI systems enhanced but also the interactivity between the instructional material and the student eliminates the passivity of videotape-based instruction.

This guide will provide information on how instructional strategies based on the use of interactive-video materials work, what equipment is needed, and how to establish and maintain a worksite training program.

COURSE  
COMPONENTS

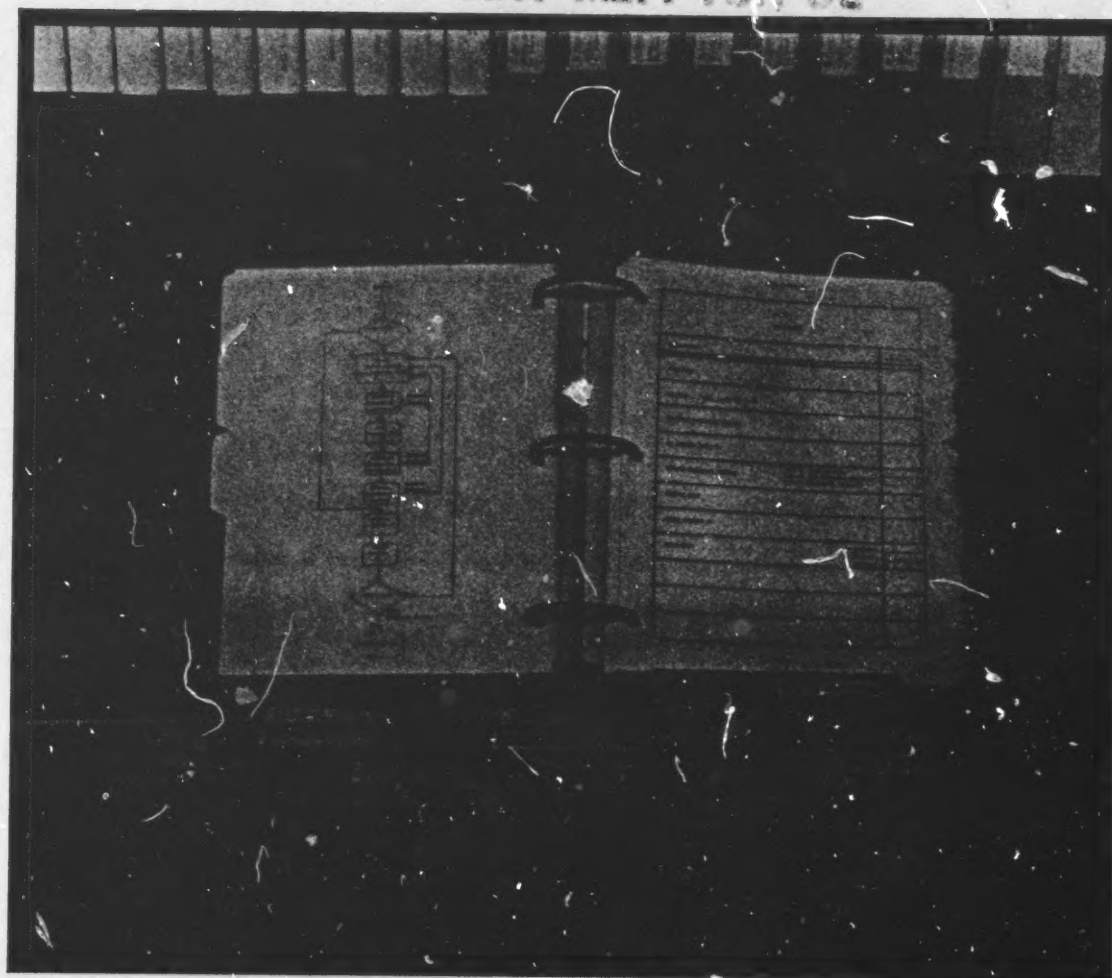


FIGURE 1. THE DC ELECTRONICS COURSE MATERIALS INCLUDE A STUDENT BINDER, VIDEOTAPES, AND SOFTWARE STORED ON DISKETTES.

## INSTRUCTIONAL COMPONENTS

The interactive-video, dc electronics course consists of the following instructional components: pre/post tests, homework review, theory lessons, skill modules, and lab jobs. The entire course is stored on forty videotapes, seventy-two diskettes, and printed material included in the student binder. Figure 1 shows the instructional materials for one of the fourteen modules comprising the dc electronics course. These procedures are performed in the sequence prescribed by the flowchart included in each module in the student binder. See Figure 2.

### Pre/Post Tests

The pre/post test is a computer activity that provides for the testing of student comprehension at the beginning (pretest) and at the end (post-test) of each module. Since any test is designed to evaluate learner comprehension at a specific point in the instructional program, the test program includes a number of checks to determine whether the student asking to take a specific test is at the appropriate point in his/her course of study.

The pre-test may be taken only once. The pre-test will determine if a student's current understanding will allow portions of the instructional program to be bypassed.

The post-test may be taken up to three times. A "pass" on the post-test is equivalent to 90% competency, meaning that a minimum score of nine questions correct out of ten was attained. A "pass" on the post-test is required in order to go into the next module. This seemingly high requirement for a passing score is required because of the self-paced nature of the course. It is better for the student to review any missed questions immediately and retest than to go on without retesting. The missed questions will certainly come up again in future modules and quite possibly cause problems in the understanding of new concepts.

The test program selects ten questions out of a bank of questions and prepares the test. When the first question appears, four selections will appear as the possible answers. Only one of the four answers is correct. The student makes a selection by pressing one of four keys (A, B, C, D). Also, there is a time limit on the questions which is set individually for each question. The computer "bell" will sound when the "halfway" mark is reached.

When the test has been completed, the computer will tell the student how many of the ten questions were answered correctly. If the score is a PASS (90% or better), a CONGRATULATIONS message will appear. In any event, the test program will proceed by reviewing any missed questions. This is done so that the student

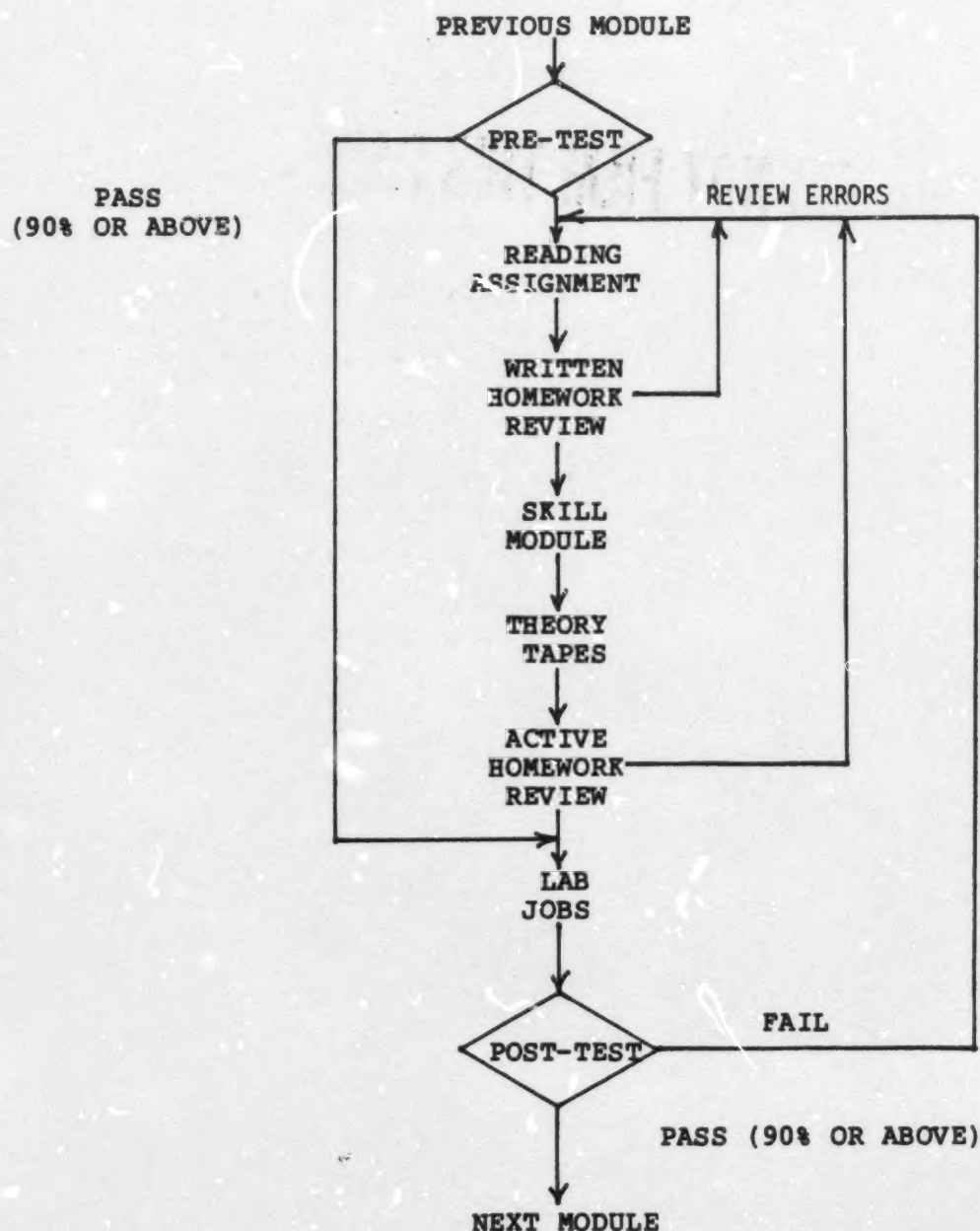


FIGURE 2. GENERAL FLOWCHART SHOWING THE INTERRELATIONSHIP OF INSTRUCTIONAL COMPONENTS FOR A MODULE.

can see exactly what questions were missed and why.

### Homework Review

The Active Homework Review program is a CAI activity whose purpose is to provide practice questions for the student. Ideally, these questions should be completed as soon after the completion of the reading assignment as possible and in conjunction with the Written Homework Review assignment found in the student binder. Both activities are intended to be self-correcting for the student.

When running the active homework review, it is necessary only to insert the ACTIVE REVIEW diskette for the appropriate module into Disk Drive #1 of the computer. Upon seeing the first question, the student must enter the letter of the BEST answer. The computer will respond with either a correct or incorrect response, and either proceed to the next question or repeat the same question, depending on whether or not the question was answered correctly. It is important to note that the program will not advance to the next question unless the present question is answered correctly. The active homework review program will provide the same questions each time it is run.

### Theory Tapes

Interactive theory tapes combine computer-assisted-instruction and videotape instruction. The principle mode of instruction used in the theory tapes as well as the lab and skill modules to be discussed next is via videotape. To this is added the advantage of controlling the videotape with the computer.

Hence, we can move the tape to the desired location, play a section of the tape, stop the tape, and then ask the student a question. Depending on the answer given, the program can proceed to the next section or repeat a portion of the same section. In addition, interactive-video allows the insertion of extra text pages as well as providing hints and remedial helps.

In the theory tapes, material is presented in a lecture/demonstration format in much the same manner as a traditional classroom setting. As with any videotape, the information presented can be reviewed at any time as deemed necessary by the student. Reaching the end of the activity (i.e. having answered all questions correctly) is interpreted by the System Manager as a successful completion of the activity (a PASS).

The initialization portion of the activity allows the student who has seen all or part of an activity previously to go to any segment desired rather than start at the beginning of the activity. In such a manner, the student can use several sessions to complete an activity.

Two operator controls available to the student are:

SPACE BAR -- Pressing the Space Bar causes the tape to pause; pressing it again causes the tape to resume playing. This function is on a timer where it will continue automatically after approximately one minute.

'H' KEY -- Pressing the 'H' key displays a menu which allows the student to review a portion of the tape just viewed or select another option

When the 'E' key is pressed while the videotape is playing, the following menu will appear on the screen:

A -- REWIND 20 SECONDS  
E -- FAST FORWARD TO THE NEXT STOP  
C -- RETURN TO MENU  
D -- QUIT  
E -- CONTINUE

The 'A' option allows the student to go back and review a section just covered. It is best to emphasize that the student should use this option IMMEDIATELY upon discovering that a review is necessary.

The 'B' option allows the student to 'skip over' video segments if the material is already understood and the student wants to proceed to the question at the end of the segment. If it turns out that the student does not know the material after all, the question most likely will be answered incorrectly and a review of the section will follow automatically. This option is most appropriate for reviewing material already covered.

The 'C' option is used to return to the main menu which lists the segments of the activity. This option is used when an activity was previously terminated before completion of the activity and the student wants to resume from where the activity was terminated.

The 'D' option allows the student to quit before completing the activity, usually because there is not enough time in one study session to finish. This option tells the student what segment was being worked on when option D was invoked. The computer then rewinds the tape.

The 'E' option allows the student to continue playing the tape from the point where it was stopped.

## Lab Jobs

The interactive lab jobs operated basically in the same manner as the theory tapes. The additional component is obviously student performed lab activities. Procedures and techniques are demonstrated on videotape and results of the lab activity are checked by the computer. If the results fall within an 'expected range', the the tape continues. If not, the technique or procedure is reviewed.

The interactive materials were produced using a specific set of electronics instruments. The equipment list is included in a later section of this guide. Although it is advisable to use the same models of test instruments so that the student station matches the equipment shown on the videotapes, it is not absolutely necessary. However, it should be emphasized that additional helps such as special handouts and/or videotape materials will have to be available to facilitate the adaptation of course materials to the student's unique setting.

The inclusion of lab jobs into the instructional package makes this mode of instruction the most complete to date. Certainly, courses such as the Heathkit courses, do so. However, prior self-study courses existed only in written or written/audio formats. Interactivity extends the capability of remote student stations and increases the effectiveness of lab activities by taking advantage of video storage technologies.



**FIGURE 3. AN IMPORTANT COMPONENT IN THE INSTRUCTIONAL PACKAGE IS THE LABORATORY ACTIVITY. INTERACTIVE LAB JOBS ENABLE STUDENTS TO DEVELOP KEY OCCUPATIONAL SKILLS.**

## STUDENT BINDER

The Student Binder/Course Notebook is the student's guide to the course and details which activities to do in each module and the order in which to do them. Specific information is provided to aid the student in the successful completion of many of the activities, particularly the Lab Jobs and Skill Modules. The Student Binder also includes the homework review questions to be used after each reading assignment. The following is a brief summary of each part of the Student Binder.

Module Objectives -- Tells the student exactly what will be learned in each module.

Reading Assignments from Textbook -- These assignments are to be completed at the beginning of each module, and may be completed outside of the on-site training time, due to the fact that the training station equipment is not required to complete the activity.

Written Homework Review -- These exercises are non-graded practice questions and are provided in the module divider section for each module. Answers are provided in the appendix. These may also be completed outside of on-site training time.

Checklist -- The check list is an instructional management tool to be used by the student to insure orderly use of the interactive and non-interactive course components.

## Module Divider Sections

The principal section of the Student Binder /Course Notebook contains the module divider sections. These sections will be most important to the student because he/she will be referring to them regularly while working on course activities.

The List of Module Objectives is general information for the student providing goals for the module. It is particularly useful when the student is ready to take a Post-Test, as a check of his/her preparedness for the test.

The Flowchart is the student's guide as to which activities to do and the order in which to do them in order to accomplish the objectives of the module. Each module is divided into a "theory" section and a "practical" section. The theory section includes reading assignments, homework review (both written and active) and theory tapes. The practical section consists of Lab Jobs and Skill Modules.

The Checklist is the student's record of his/her progress through the course, and should be kept up to date by the student. The Field Instructor can use this checklist to verify that the student has completed all the required activities for a particular module.

The Written Homework Review questions are contained in each module divider section. The answer keys found in Appendix A of the Student Binder provide a check for the student. These are self-graded practice questions and are not turned in unless specifically requested by the Field Instructor. The answer keys contain both the correct answer for each question as well as an explanation for the correct answer. When appropriate, the answer key may also provide a page number reference in the textbook.

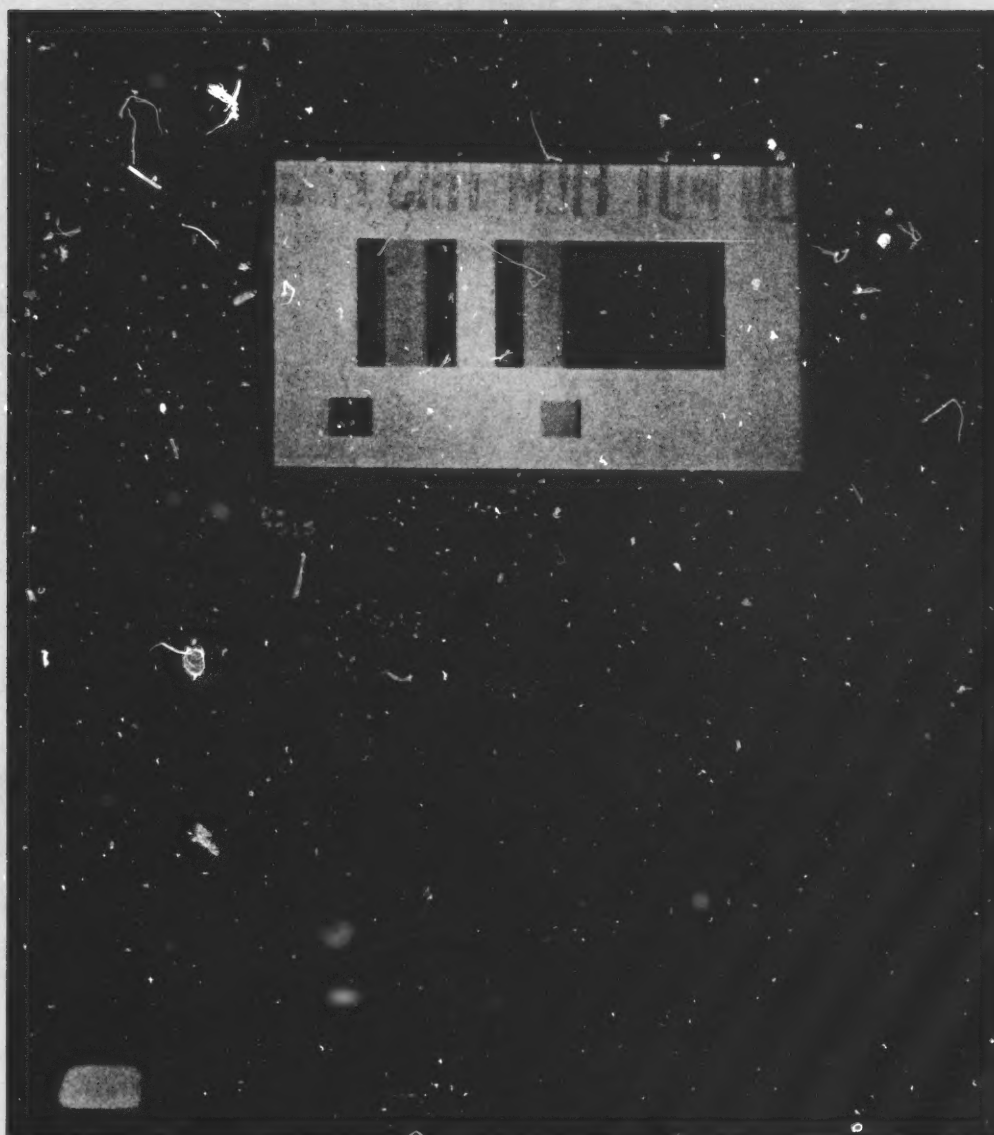


**FIGURE 4. INTERACTIVE SKILL DEVELOPMENT MODULES ENABLE THE STUDENT TO PRACTICE AND PERFECT KEY OCCUPATIONAL SKILLS SUCH AS READING RESISTOR COLOR CODES.**

## DC ELECTRONIC COURSE CONTENT

### MODULE ONE - MATTER AND CHARGES

Composition of Matter

Electrostatics

### MODULE TWO - CURRENT FLOW AND CIRCUITS

Current Flow

The Electric Circuits

Measuring Current

Theory Tape # 2 - Scientific Notation and Metric  
Prefixs

Skill Module # 1 - Volts-Amps-Ohms-Watts

Appendix: Scientific Notation

### MODULE THREE - ELECTROMOTIVE FORCE

Electrical Force

Producing EMF

Batteries

Theory Tape # 3 - Electromotive Force

Skill Module # 8 - Meter Scales

Skill Module # 9 - The Analog Multimeter

Skill Module # 10 - The Digital Multimeter

Theory Tape # 9A - The Voltmeter

Lab Job # 1 - Measuring Voltage

### MODULE FOUR - BATTERIES AND VOLTAGE DROPS

Connecting Batteries

Voltage Rises and Voltage Drops

Concept of Ground

Measuring Voltage

Theory Tape # 4 - Voltage Rises and Drops

Skill Module # 2 - The Calculator - Getting Started

#### MODULE FIVE - RESISTANCE

Basic Concepts

Resistors

Connecting Resistors

Color Code Disk

Skill Module # 3 - The Calculator: Prefixes and  
Resistance Problems

Theory Tape # 5A - Resistance

Theory Tape # 5B - Series-Parallel Resistive Circuits

Theory Tape # 9B - The Ohmmeter

Lab Job # 2 - Measuring Resistance

Lab Job # 3 - Using the Lab Breadboard

Lab Job # 4 - Continuity, Opens and Shorts

Lab Job # 6 - Measuring Resistance Characteristics

#### MODULE SIX - OHM'S LAW AND POWER

Ohm's Law

Power

Skill Module # 4 - The Calculator: Prefixes and Ohm's  
Law Problems

Theory Tape # 6 - Ohm's Law and Power

Lab Job # 7 - Verifying Ohm's Law

Lab Job # 8 - Power

**MODULE SEVEN - MAGNETISM**

The Magnetic Field

Electricity and Magnetism

Induction

Magnetic and Electromagnetic Applications

Theory Tape # 7A - Magnetism

Theory Tape # 7B - AC and DC Generators

Lab Job # 9 - Electromagnetism

Lab Job # 10 - Magnetic and Electromagnetic Devices

**MODULE EIGHT - CURRENT AND AMMETERS**

The Meter Movement

The Ammeter

Theory Tape # 8 - The Ammeter

Lab Job # 5 - Measuring Current

**MODULE NINE - VOLTMETERS**

The Voltmeter

The Ohmmeter

Multimeters

Theory Tape # 9C - The Multimeter

**MODULE TEN - SERIES, PARALLEL, AND VOLTAGE DIVIDERS**

Simple Circuits

Voltage Dividers

Theory Tape # 10A - Series-Parallel Resistive Circuits

Theory Tape # 10B - Voltage Dividers

Lab Job # 11 - Loading Effects of Voltmeters

**MODULE ELEVEN - CIRCUIT ANALYSIS**

Bridge Circuits

Kirchhoff's Law

Superposition Theorem

Theory Tape # 11A - Kirchhoff's Law

Theory Tape # 11B/12 - Superposition Theorem, Thevenin's  
Theorem, Norton's Theorem

Lab Job # 12 - Resistance Bridge Circuits

**MODULE TWELVE - THEVENIN'S AND NORTON'S THEOREM**

Thevenin's Theorem

Norton's Theorem

Theory Tape # 11B/12 - Superposition Theorem, Thevenin's  
Theorem, Norton's Theorem

**MODULE THIRTEEN - INDUCTANCE AND CAPACITANCE**

Inductance

Capacitance

Capacitors

Theory Tape # 13 - Inductors and Capacitors

**MODULE FOURTEEN - CAPACITIVE CIRCUITS**

RC Time Constants

Capacitors in Combination

Theory Tape # 14 - RC Time Constants

Lab Job # 13 - RC Time Constants

Lab Job # 14 - Capacitors in Series and parallel

Lab Job # 15 - Using Capacitors

## LAB JOB TITLES

|            |                                      |
|------------|--------------------------------------|
| LAB JOB 1  | MEASURING VOLTAGE                    |
| LAB JOB 2  | MEASURING RESISTANCE                 |
| LAB JOB 3  | USING THE LAB BREADBOARD             |
| LAB JOB 4  | CONTINUITY, OPENS, AND SHORTS        |
| LAB JOB 5  | MEASURING CURRENT                    |
| LAB JOB 6  | MEASURING RESISTANCE CHARACTERISTICS |
| LAB JOB 7  | VERIFYING OHM'S LAW                  |
| LAB JOB 8  | POWER                                |
| LAB JOB 9  | ELECTROMAGNETISM                     |
| LAB JOB 10 | MAGNETIC AND ELECTROMAGNETIC DEVICES |
| LAB JOB 11 | LOADING EFFECTS OF THE VOLTMETER     |
| LAB JOB 12 | THE RESISTANCE BRIDGE CIRCUIT        |
| LAB JOB 13 | RC TIME CONSTANTS                    |
| LAB JOB 14 | CAPACITORS IN SERIES AND PARALLEL    |
| LAB JOB 15 | USING CAPACITORS                     |

**SKILL MODULE TITLES**

|                        |                                                          |
|------------------------|----------------------------------------------------------|
| <b>SKILL MODULE 1</b>  | <b>VOLTS, AMPS, OHMS, WATTS</b>                          |
| <b>SKILL MODULE 2</b>  | <b>THE CALCULATOR - GETTING STARTED</b>                  |
| <b>SKILL MODULE 3</b>  | <b>THE CALCULATOR - PREFIXES AND RESISTANCE PROBLEMS</b> |
| <b>SKILL MODULE 4</b>  | <b>THE CALCULATOR - PREFIXES AND OHM'S LAW PROBLEMS</b>  |
| <b>SKILL MODULE 8</b>  | <b>METER SCALES</b>                                      |
| <b>SKILL MODULE 9</b>  | <b>THE ANALOG MULTIMETER</b>                             |
| <b>SKILL MODULE 10</b> | <b>THE DIGITAL MULTIMETER</b>                            |



FIGURE 5. STUDENTS MUST DEMONSTRATE SATISFACTORY COMPREHENSION OF A SUBJECT CONTAINED IN A MODULE BEFORE PROCEEDING ON TO THE NEXT MODULE. TEST QUESTIONS ARE ALL MULTIPLE CHOICE.

DC ELECTRONICS  
COURSE OBJECTIVES

**MODULE 1 - MATTER AND CHARGES**

At the end of this module, the student will be able to:

1. Identify examples and descriptions of each of the following terms: compound, element, ion, and charge.
2. Name the various parts of the Bohr Model of an atom when given a description of each part.
3. Identify the factors and forces that produce a balanced atom.
4. Name the electrical charge associated with each of the following: atom, electron, proton, neutron, nucleus, ion.
5. Identify a description of Coulomb's Law.
6. Recognize examples and descriptions of the process of electrostatically charging a material.

**MODULE 2 - CURRENT FLOW AND CIRCUITS**

At the end of this module, the student will be able to:

1. Identify examples and descriptions of each of the following terms: current, conductor, insulator.
2. Name the various elements comprising a complete circuit and identify a description of each.
3. Differentiate between schematic and pictorial diagrams and select applications of each.
4. Recognize descriptions of various basic electronic component schematic symbols.
5. Convert values from common notation to scientific notation.
6. Convert values from scientific notation to common notation.
7. Convert values from engineering notation to common notation.

### MODULE 3 - ELECTROMOTIVE FORCE

At the end of this module, the student will be able to:

1. Calculate the terminal voltage, given a series-parallel combination of electrical cells.
2. Identify the description of the following terms: cell, battery, primary cell, secondary cell, polarization, internal resistance, coulomb, ampere, volt, electrolyte.
3. Differentiate between a primary cell and a secondary cell.
4. Identify the six forms of electrical energy and a device or method to convert each to perform work.
5. Match single sentence definitive phrases with each of the following terms: electron, proton, neutron, element, molecule, conductor, semiconductor, ion, positive and negative charges, free electron.
6. Identify the following terms by matching each with a descriptive phrase: voltage, electromotive force, potential difference, power.

### MODULE 4 - BATTERIES AND VOLTAGE DROPS

At the end of this module, the student will be able to:

1. Recognize a description of the electrical characteristics of cells connected in series and in parallel.
2. Identify the differences between a voltage drop and a voltage rise.
3. Indicate how a ground connection permits the generation of both positive and negative voltages.
4. Calculate the voltage drop across a load with the formula  $\text{volts} = \text{joules/coulombs}$ .
5. Recognize a description of the proper method of connecting a voltmeter to a circuit in order to measure a voltage.

## MODULE 5 - RESISTANCE

At the end of this module, the student will be able to:

1. Identify the definitions of the following terms: resistance, conductance, resistivity.
2. Recognize the definition for the ohm given in terms of volts and amps.
3. Indicate the electrical characteristics of conductors and insulators.
4. Identify how the length, cross-sectional area, resistivity, and temperature of a substance affect its resistance.
5. Determine a resistor's value in ohm's, its power rating in watts, and its tolerance given a description of a resistor.
6. Calculate the total resistance of resistors connected in series.

## MODULE 6 - OHM'S LAW AND POWER

At the end of this module, the student will be able to:

1. Recognize a description of the three forms of the Ohm's Law formula.
2. Identify a description of the relationship between current and voltage as stated in Ohm's Law.
3. Recognize a description of the relationship between current and resistance as stated in Ohm's Law.
4. Calculate the values of current, voltage, or resistance, using Ohm's Law, given any two of the three values.
5. Identify a definition of power.
6. Recognize a description of the relationship between power, current, and voltage.
7. Calculate the power dissipated in a circuit given any two of the three values of : current, voltage, and resistance.

## MODULE 7 - MAGNETISM

At the end of this module, the student will be able to:

1. Identify a definition of the basic law of magnetism.
2. Recognize a description of the four basic rules and characteristics of flux lines.
3. Recognize a description of the following substances: ferromagnetic, paramagnetic, and diamagnetic.
4. Identify the definitions for the following magnetic quantities: flux, flux density, magnetomotive force, permeability, retentivity, and residual magnetism.
5. Select the four factors that determine the magnitude of a voltage induced in a conductor.
6. Recognize a description of the left-hand rule of conductors, coils, and generators,
7. Identify the definition of Faraday's Law.
8. Recognize a description of the operation of a DC generator and a DC motor.
9. Recognize a description of the right-hand rule as applied in motors, meters, and electron beams in TV picture tubes.
10. Recognize a description of the operation of basic electromagnetic principles in the following devices: a loud speaker, a relay, a reed switch, and a tape recorder.

## MODULE 8 - CURRENT AND AMMETERS

At the end of this module, the student will be able to:

1. Identify the electrical characteristics of the D'Arsonval movement.
2. Identify the electrical characteristics of the Taut-Band movement.
3. Recognize a description of the rules for correct usage of the ammeter.
4. Calculate the value of the shunt resistor required to increase the current capability to a specified value given the full scale deflection current and the meter resistance.
5. Calculate the tolerance of a meter given the meter's percentage of error at full scale deflection.

## MODULE 9 - VOLTMETERS AND OHMMETERS

At the end of this module, the student will be able to:

1. Calculate the voltage necessary to produce full-scale deflection on a meter movement given the current rating and the resistance of the meter.
2. Calculate the series multiplier resistor value required to increase the voltage range of a voltmeter given the full-scale deflection current and the value of meter resistance.
3. Identify a definition for "meter sensitivity".
4. Recognize a description of the effects of voltmeter loading.
5. Calculate the loading effect of a voltmeter given the circuit resistance and the meter sensitivity.
6. Recognize a description of the electrical characteristics of an ohmmeter.
7. Calculate the value of the series multiplier resistor in an ohmmeter given the battery voltage and the current rating of the meter movement.
8. Identify the factors that determine measurement inaccuracies when using a multimeter.

## MODULE 10 - SERIES, PARALLEL AND VOLTAGE DIVIDER CIRCUITS

At the end of this module, the student will be able to:

1. Recognize a description of the electrical characteristics of a simple series circuit.
2. Calculate the unknown value of current, voltage, or resistance in a simple series circuit given the other two values.
3. Recognize a description of the electrical characteristics of a simple parallel circuit.
4. Calculate the unknown value of current, voltage, or resistance in a simple parallel circuit.
5. Calculate the power dissipated by any component in a series, parallel, or series-parallel circuit.
6. Calculate the unknown value of current, voltage, or resistance in a series-parallel circuit given the other two values.

7. Calculate the resistance values of a voltage divider that will produce the given voltage and current requirements of the loads connected to the voltage divider.

#### MODULE 11 - CIRCUIT ANALYSIS

At the end of this module, the student will be able to:

1. Recognize a description of the electrical characteristics of a balanced/unbalanced bridge circuit.
2. Calculate the output voltage, the output current, and the branch currents of a balanced/unbalanced bridge circuit.
3. Identify two practical applications of the bridge circuit.
4. Recognize a description of the electrical characteristics of a Wheatstone Bridge.
5. Identify a description of Kirchhoff's Voltage Law.
6. Identify a description of Kirchhoff's Current Law.
7. Recognize a description of the steps to follow when writing an equation that describes a loop circuit.

#### MODULE 12 - THEVENIN'S AND NORTON'S THEOREMS

At the end of this module, the student will be able to:

1. Identify a definition of Thevenin's and Norton's Theorem.
2. Recognize a description of a two terminal network of voltage sources and resistors that is equivalent to a given Thevenin or Norton Circuit.
3. Calculate the voltage at the output terminals of a Thevenin or Norton circuit that does not have a load resistor connected to the output terminals.
4. Calculate the maximum current a given Thevenin or Norton circuit can deliver across a short circuit connected to the output terminals.
5. Calculate the output voltage across a load resistor connected to the output terminals of a given Thevenin or Norton equivalent circuit.
6. Convert a given Thevenin equivalent circuit to a Norton equivalent circuit and vice versa.

**MODULE 13 - INDUCTANCE AND CAPACITANCE**

At the end of this module, the student will be able to:

1. Identify a definition of induction, inductance, and counter EMF.
2. Recognize a description of the physical factors that determine inductance.
3. Identify the units of inductance and capacitance.
4. Recognize a description of the definition of capacitance.
5. Recognize a description of the physical factors that determine capacitance.

**MODULE 14 - CAPACITIVE CIRCUITS**

At the end of this module, the student will be able to:

1. Recognize a description of the rate at which a capacitor charges or discharges through a resistor.
2. Calculate RC time constants given the resistance and capacitance values.
3. Calculate the capacitor voltage a given number of time constants after power has been applied to (or removed from) a given RC circuit.
4. Compute the time value prefix given the prefixes for capacitance and for resistance in the formula  $T = RC$ .
5. Calculate the total capacitance for capacitors connected in series and in parallel.
6. Calculate the voltage drop across each capacitor in a series capacitor network.

EQUIPMENT



**FIGURE 6. TRAINING STATION SET-UP SHOWING THE COMPUTER-VIDEOTAPE SYSTEM, ELECTRONIC TEST EQUIPMENT, AND INSTRUCTIONAL MATERIALS.**

## EQUIPMENT

The equipment needed at the training station is listed on the "Training Station Inventory" sheet. Besides the Apple Computer, dual disk drives, color monitor and the videotape player, the following pieces of equipment are needed: Mountain Hardware Clock Card (or equivalent), Whitney Interface Card, DOS (Disk Operating System) Disk Interface Card, Whitney Interface Box, Headphones (preferably with volume controls for each side), DOS 3.3 Master Diskette, the System Manager KEY and FILE diskettes, and interconnection cables. The interconnection cables include: three RCA phono plug to RCA phono plug cables, one RCA phono plug to BNC connector cable, and one RCA phono plug to miniature phone plug. The cables are interconnected as shown in Figure 4. It is possible that there may be some variance in the type of connectors required for these cables, depending on the actual type of equipment utilized at your location.

Inside the Apple Computer, check to see that all accessory boards are installed correctly: Mountain Hardware Clock Card in Slot # 3, Whitney Interface Card in Slot # 4, and the Disk Interface Card in Slot # 6 (the disk drives should be connected to this card with the arrows on the connectors properly matched). If you are using an Apple IIe computer and you have an 80-column card for it, the 80-column card must be removed from the computer. If installed, it will defeat the operation of the clock card. If the Whitney Interface Box is not already connected to the Interface Card via the ribbon cable, do so by plugging the cable with the edge connector from the interface box into the edge connector on the top of the interface card. Be certain that this cable crosses the card at the cutout provided on the card, so proper pin orientation between the two connectors is maintained.

If you will be using a printer with your training station, insert the printer interface card into Slot # 1 of the computer. This will allow you to use the printer as an alternate display device if desired. Check the Apple owners manual and printer manual for details on setting up the printer.

The battery adapter for the Mountain Hardware Clock Card should be attached to the connector on the clock card, with the battery adapter itself plugged into a 110-volt, 60-Hz outlet. A convenient socket for this purpose may be found on the back of the videotape player, but any nearby outlet will suffice. Additional information on the installation and operation of the Mountain Hardware Clock Card is included in the owner's manual.

Finally, connect the cable on the opposite end of the Whitney Interface Box to the remote control jack on the back of the videotape player. The "M" jack should go to the monitor, the "A" jack to the Apple computer, and the "T" jack to the videotape player. There should also be a cable from the Channel 2 audio output jack on the videotape player to the "cassette in" jack on the Apple Computer. If your color monitor contains an audio

input, you will need to run a cable from the Channel 1 audio on the videotape player to the audio input on your monitor. Otherwise, you can use the headphones for audio (desirable if there is more than one training station in the same room). Make sure that all three components -- videotape player, monitor, and Apple Computer -- are connected to a source of 110-volts AC. It is recommended that some form of line isolation be provided for the computer and monitor to prevent any possible interactions or disruptions due to line surges and variations. The necessity of this precaution will depend on the specific type of monitor in use at your site and the quality of AC power available.

### EQUIPMENT AND SUPPLIES LIST

#### Equipment

|                                     |        |
|-------------------------------------|--------|
| Apple Computer                      | 1 each |
| Disk Drives                         | 2 each |
| Color Monitor                       | 1 each |
| Videotape Player                    | 1 each |
| FET Multimeter (Heath SM-5225)      | 1 each |
| Digital Multimeter (Leader LDM-651) | 1 each |
| Tri-Power Supply (Heath SP-2718)    | 1 each |
| Calculator (Hewlett Packard)        | 1 each |
| Headphones                          | 1 each |

#### Lab Hardware

|                               |         |
|-------------------------------|---------|
| DC Parts Kit                  | 2 boxes |
| Jumper Kit                    | 1 box   |
| Protoboard                    | 1 each  |
| Soldering Iron & Stand        | 1 each  |
| Electronic Doorbell (TD-1089) | 1 each  |
| Darkroom Timer (PT-1500)      | 1 each  |
| Color Code Chart              | 1 each  |

**Test Leads**

|                                |        |
|--------------------------------|--------|
| Red Banana to Miniclip         | 1 each |
| Black Banana to Miniclip       | 1 each |
| Red Miniclip to Miniclip       | 1 each |
| Black Miniclip to Miniclip     | 1 each |
| GR to Miniclip                 | 2 each |
| Black Probe Lead               | 1 each |
| Red Probe Lead                 | 1 each |
| Red Banana to Alligator Lead   | 1 each |
| Black Banana to Alligator Lead | 1 each |
| BNC to Miniclip                | 1 each |

**Instructional Materials**

|                                         |        |
|-----------------------------------------|--------|
| DC Electronics Textbook (Heath EB-6101) | 1 each |
| DC Electronics Student Binder           | 1 each |

**Other Items:**

|                              |        |
|------------------------------|--------|
| Workstation Hand Tools       | 1 set  |
| Diagonal Cutters             |        |
| Needle Nose Pliers           |        |
| Wire Strippers               |        |
| Small Screwdriver            |        |
| Whitney Interface Box        | 1 each |
| Whitney Interface Card       | 1 each |
| Mountain Hardware Clock Card | 1 each |
| Interconnection Cables       | 1 set  |
| DOS 3.3 Mater Diskette       | 1 each |
| System Manager Key Diskette  | 1 each |
| System Manager File Diskette | 1 each |

## DC Resistor Kit

|                   |                    |                     |
|-------------------|--------------------|---------------------|
| 1 - 4.7 ohms 5%   | 1 - 470 ohms 1W    | 1 - 5.1K ohms 1/2W  |
| 1 - 10 ohms 1W    | 1 - 560 ohms 1/4W  | 3 - 10K ohms 1/2W   |
| 1 - 10 ohms 1%    | 2 - 1K ohms 1/2W   | 1 - 15K ohms 1/4W   |
| 1 - 15 ohms 1/2W  | 1 - 1K ohms 1W     | 2 - 22K ohms 1/2W   |
| 1 - 22 ohms 1/2W  | 1 - 1K ohms 1%     | 1 - 33K ohms 1/2W   |
| 1 - 68 ohms 1/2W  | 1 - 1.2K ohms 1/2W | 1 - 68K ohms 1/2    |
| 3 - 100 ohms 1/2W | 2 - 2K ohms 1/2W   | 1 - 100K ohms 1W    |
| 1 - 100 ohms 1%   | 1 - 2.2K ohms 1/4W | 1 - 220K ohms 1/2W  |
| 1 - 100 ohms 2W   | 1 - 2.2K ohms 1/2W | 1 - 1M ohms 1/2W    |
| 2 - 200 ohms 1/2W | 1 - 4.7K ohms 1/4W | 1 - 10M ohms 1/2W   |
| 1 - 220 ohms 2W   | 1 - 4.7K ohms 1/2W | 1 - 100M ohms 1/2W  |
| 1 - 470 ohms 1/2W |                    | 1 - 1000M ohms 1/2W |

## DC Miscellaneous Kit

|                                   |                                             |                                                                          |
|-----------------------------------|---------------------------------------------|--------------------------------------------------------------------------|
| 1 - Compass                       | 2 - Bayonet Light<br>Sockets                | 1 Relay                                                                  |
| 1 - Magnet                        | 2 - #49 Bulbs                               | 1 - DPDT Switch                                                          |
| 1 - Photo Resistor                | 2 - #57 Bulbs                               | 2 - Magnetic Reed<br>Switches                                            |
| 2 - Thermistors<br>(#9-34, #9-32) | 1 - 1/16 Amp Fuse                           | 3 - Capacitors<br>10 mfd, 15 WVDC<br>50 mfd, 15 WVDC<br>500 mfd, 15 WVDC |
| 10-ft - #22 Solid Wire            | 2 - Potentiometers<br>(200 ohm, 100 K ohms) |                                                                          |

Setting up a worksite training program is not a simple matter. It is not just a matter of transporting equipment and supplies to the company plant. A high degree of coordination between the company and the College is required. Important considerations include the allocation of space within the company plant, advertising the training program through internal channels, access by students into areas that require security clearance, field instructor access to the student station, and the integration of the interactive-video training program into the company's overall training plan.

Hence, the first and most crucial step is the identification of a key individual within the company that will serve as the primary contact person and advocate for the program. This individual may be from a training department or college relations department. The names of the department will vary from company to company but it must be a group that has company-wide visibility. Working through managers, as an initial step, should be used only as a last resort. The disadvantage of this strategy is that the support for the program will be localized and highly dependent on that specific manager or group of managers. If the manager moves out of his current position, the program is in jeopardy and most likely will need rebuilding with the new manager.

The goal of the program is to establish a on-going worksite training program that is of general interest throughout the company and independent of any one individual within the company for its continued existence. It should, therefore, be a project associated with a company-wide department or position.

#### Company Representative

The company representative will actually get the program going. It is this individual's job to sell the concept to the corporate management. Hence, the first task is for this individual to be fully oriented to the worksite training concept and operation of the instructional program.

Approval for the worksite training program not only requires support for the concept, but also allocation of resources: space, equipment, tuition reimbursement benefits, and security. It is important that the training program fit the culture of the company that is going to use it.

One student station requires about 64 sq. ft. of floor space. Within this space, there should be a desk with drawer storage, a file cabinet, a table, and a locking bookcase. The space should have a minimum of six outlets with at least four outlets on a common switch.

Internal promotion of the worksite training program is crucial. Typical strategies include course announcements sent to supervisors within the company. However, this may not reach the target student population for a number of reasons. First the manager may not pass the information on to his department. Second, only managers in technical areas may get the information leaving a vast number of other employees unaware of this opportunity. There may be a number of other reasons for the information not reaching interested students. Therefore, a number of different advertising strategies should be used, e.g. bulletin boards, company newsletters, and personnel representatives.

The company representative will also have to request security clearance for the students involved the worksite training program. Employees may work at other company locations and not have clearance at the site where the student station is located. Security may also be the likely coordinator of the keys to the student station which means a check-in/check-out procedure needs to be established.

On-going program evaluation using company procedures will also be a key component of the worksite program. It is imperative that the program be perceived as being valuable to the company and its employees. The company representative will most likely be administering this evaluation.

#### Storage of Materials

The forty videotapes and fourteen diskette storage boxes containing the software should be stored in a secure area. A locking bookcase works well for this purpose. The materials should be placed in order on the bookshelves with the labels clearly visible.

All other components, tools, and equipment should be stored in the drawers of the desk. Also stored in the center drawer of the desk should be two diskettes: the File Diskette and the Active Homework Review Diskette.

The following forms should be available at the worksite student station: Trouble Report Sheet and Student Station Log Sheets.

The file cabinet is for Field Instructor use. Extra copies of the student binder, extra copies of the textbook, and back-up and field instructor diskettes can be kept in the file cabinet.

The student station should have a telephone. This phone will serve as a hot-line back to the campus in the event that a problem occurs at the student station. This telephone line can handle equipment failure reports, questions regarding the subject matter, and other matters related to the operation of the student

station.

### Log Sheets

Since the System Manager does not keep track of how much time each student uses the student station, a log sheet on a clipboard should be used. A sample of the log sheet is shown in Figure 5. The amount of time that the student station is used can be computed from these sheets.

### Student Station Schedule

To eliminate conflicts in the use of the student station each student signs up for specific blocks of time during the week. The student who has signed up for a specific block of time has priority to use the system. If for some reason, that person signed up for a specific block of time does not use it, then other persons may use the system. Open blocks of time should be left in the student station schedule to allow students to sign-up for extra time segments as needed.

### Student Directory

A current student directory should be maintained at all times. This directory would not only be used by the company representative and field instructor but also security in checking out keys to the student station. The student directory should include the student's name, job title, supervisor's name, and phone number.

FIGURE 8. SAMPLE LOG SHEET FOR THE STUDENT STATION.

|          | STUDENT STATION SCHEDULE |         |           |          |        |
|----------|--------------------------|---------|-----------|----------|--------|
|          | MONDAY                   | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY |
| 7:00 AM  |                          |         |           |          |        |
| 8:00 AM  |                          |         |           |          |        |
| 9:00 AM  |                          |         |           |          |        |
| 10:00 AM |                          |         |           |          |        |
| 11:00 AM |                          |         |           |          |        |
| 12:00 PM |                          |         |           |          |        |
| 1:00 PM  |                          |         |           |          |        |
| 2:00 PM  |                          |         |           |          |        |
| 3:00 PM  |                          |         |           |          |        |
| 4:00 PM  |                          |         |           |          |        |
| 5:00 PM  |                          |         |           |          |        |
| 6:00 PM  |                          |         |           |          |        |
| 7:00 PM  |                          |         |           |          |        |
| 8:00 PM  |                          |         |           |          |        |
| 9:00 PM  |                          |         |           |          |        |

The operation of the worksite training program rests on the shoulders of the Field Instructor. It is the effectiveness of the Field Instructor that will determine if the program serves the needs of the company and its employees. The Field Instructor will be responsible for qualifying students, setting up and maintaining the student station, coordinating the operation of the program with company representatives and supervisors of the students, maintaining records, and evaluating the student's performance at the end of the training period.

#### Student Qualification

The entry requirements will be determined by the goals of the training program. If the program is of an occupational upgrading nature, then the program may or may not be tied to a degree program at a College. If the training is tied to an Associate Degree Program, the entry level requirements will be set by the College granting the degree.

In either event, the two prerequisites that are most important are the mathematics and reading ability of the student. The student should be at the elementary algebra level and should be able to read and write at the high school level.

Other factors that may affect the acceptance of a student into the program are potential for advancement, recommendation of the supervisor, and the motivation and the ability of work independently of others.

#### Student Orientation

A student orientation session, either in a group format or individually, is needed to acquaint the student with the program and the use of the student station. The following items should be discussed at the student orientation session:

- \* Course content and requirements
- \* Use of the student binder
- \* Orientation to the Apple Computer and Videotape Player
- \* Use of the interactive-video course materials
- \* Trouble reports and use of the 'hot-line' phone numbers

Following the group presentation, the Field Instructor should schedule some one-on-one time with each student. This should be done in the two-week period following the general orientation session.

## SYSTEM MANAGER RECORD KEEPING SYSTEM

The System Manager is a software package which is used primarily by the field instructor primarily as a record-keeping device. It provides an accurate accounting of each student's progress in the course for which he/she is enrolled. The program limits access to the system to only those students who are actively enrolled.

The System Manager package comes in floppy disk form. The package consists of two separate diskettes: the KEY DISKETTE and the FILE DISKETTE. The Key Diskette is used by the Field Instructor to control and manipulate the actual record keeping files. This diskette is not available to the student. The Key Diskette always goes in Drive # 1.

The File Diskette is resident in Drive # 2 and contains all of the record keeping files necessary for the operation of the student station. This diskette must be present in Disk Drive # 2 of the computer for all activities of the training program. Whenever an activity is run (with only a few exceptions), the File Diskette is activated and the student is requested to enter his/her identification number. This number must be on file in the System Manager before the activity will proceed.

The importance of the record keeping function can be more fully realized when comparing a self-paced, learner-centered program with the more traditional lecture or lecture/laboratory approach. In the case of the latter, the instructor provides the record keeping function by recording each student's performance on homework, lab experiments, and tests. However, in a self-paced program, the importance of some type of automatic record-keeping mechanism becomes much more evident. When the learning activities are not being continually monitored by an instructor, the activity must in effect 'grade itself' and provide a record of the student's actual accomplishments for later evaluation.

It is important to point out that the System Manager is not intended to be an attendance monitoring device. It was not designed with this feature in mind. As it stands now, it is not capable of measuring elapsed time. It does record the time of completion of an activity, or if the activity was not completed, the time of initial sign-on for the activity. In the DC electronics course there are some non-graded activities (e.g. Apple Handshake and the Color Code Disk) which do not utilize the System Manager at all.

## THE RECORD KEEPING FILES

The primary record keeping files are the GROUP FILE and the LOG FILE. Within these two files are kept each student's progress records. These two record-keeping files are not directly accessible by the user but must be accessed by the use of other files resident on the Key Diskette.

The GROUP FILE contains the list of students assigned to the training station, their identification numbers, and progress information on each of the following categories: Pre/Post Test, Theory Tape, Lab Job, and Active Review/Skill Module. The LOG FILE lists the activities in chronological order and shows whether or not the activity was actually completed. A sample of the Group File display is shown in Figure 7. It lists the students by name and indicates their standing in each of the four categories (A = Pre/Post Test, B = Theory Tape, C = Lab Job, and D = Active Review and/or Skill Module). The number shown in each column is a two digit number which indicates the number assigned by the System Manager to that particular activity.

The Log File, as illustrated in Figure 8, provides a chronological listing of all activities accomplished on the training station during the reporting period. A "LOGIN" means simply that the student started the activity but did not complete it. A "P" followed by "0/00" indicates a successful completion of any activity except a Pre/Post Test. The tests will be displayed as a letter grade (A, B, or C) if it is a passing score (i.e. a score of 9 out of 10 or better). An "X" will be awarded if a passing score is not attained and it will count as a try on the test. In the case of a Pre-Test, a "T" will be awarded regardless of the score, followed by the actual score as described above. When a passing score of A, B, or C is awarded in the Log File, the Group File is automatically updated to advance the student to the next module's Pre-Test.

#### GENERAL OPERATION

The System Manager contains a variety of functions designed to aid the Field Instructor in the efficient management of student progress records for the training station. These functions include: adding names to the Group File, deleting names from the Group File, printing or displaying both the Group and the Log Files, changing the company name as displayed on the Group or Log File printouts, and renewing the Log File at the end of a reporting period.

When the System Manager program is loaded, the Main Menu will be displayed. The Main Menu is shown in Figure 9. The menu will allow the user to select the desired operation. When the selected operation is complete, the computer returns to the main menu and another operation can then be selected.

The "A" and "D" operations allow the user to either add names to the Group File or delete names from the file. The "A" function is useful both when starting a new Group File initially as well as when adding names to an existing Group File. When deleting names from the Group File using the "D" operation, the user must type "YES" to actually delete the name. This step prevents the accidental deletion of a student from the file.

To change the company name as displayed on both the Group and Log Files, the "C" operation of the menu can be used. The only precaution here is that there is a twenty character limitation on the chosen company name. The name can be changed at any time as desired by the user.

When printing or displaying either the Group or Log File, use the "P" option on the menu. The program will ask whether you want to print the Group File or the Log File. Then it will query you whether you want hardcopy or not. Choose the hardcopy option only if a printer is connected to Slot # 1 of your computer.

If you need to revise or change any student records, use the "R" operation on the menu. This option is also used when you need to reset a particular student's file for a Post Test. In this case, the student would have taken the Post Test three times without a passing score (9/10 or better). His/her file must be reset before the test can be retaken. This resetting operation is necessary to ensure that the student will seek assistance with a particular module when needed.

The "B" operation is used to destroy the old Log File and start a new one. This is a very important function because the Log File must be "purged" or emptied out periodically. As a general rule, the Log File should be purged at least once a month and possibly more often depending on the amount of activity on the training station. When 100 entries have been made on the Log File, a "warning" message will appear every time the Sytem Manager program is run, indicating that the Log File must be purged as soon as possible. Note: Before using the "B" operation, get a hardcopy printout of the Log File as a permanent record.

Finally, use the "Q" operation as the method of exiting the System Manager Program. To use any other method (such as turning off the computer or typing CTRL RESET) may result in lost data.

USER: ACME ELECTRONICS

| NAME          | ID#       | A    | B     | C    | D    |
|---------------|-----------|------|-------|------|------|
| B. STUDENT    | 123445678 | 1-00 | 1-00  | 1-00 | 1-00 |
| S. TECHNICIAN | 321778923 | 7-00 | 9-09  | 8-07 | 4-04 |
| W. CLERK      | 704339876 | 7-01 | 9-10  | 8-07 | 3-03 |
| K. STEADY     | 553006454 | 8-03 | 13-25 | 5-12 | 3-03 |

FIGURE 7. SAMPLE LISTING OF THE GROUP FILE.

USER: ACME ELECTRONICS

NAME: K. STEADY

| DATE  | TIME     | TST-TR | RESULT    |
|-------|----------|--------|-----------|
| 06/06 | 19,08,28 | A06-01 | F( 6/10)X |
| 06/06 | 19,11,44 | A06-02 | LOGIN     |
| 06/07 | 14,09,07 | A06-02 | P(10/10)B |
| 06/07 | 14,21,10 | A07-00 | F( 6/10)T |
| 06/13 | 19,26,59 | B08-21 | P( 0/00)* |
| 06/13 | 20,43,57 | B09-22 | P( 0/00)* |
| 06/14 | 20,13,14 | C09-10 | P( 0/00)* |
| 06/20 | 18,43,41 | C10-11 | P( 0/00)* |
| 06/20 | 19,53,37 | A07-01 | P(10/10)A |
| 06/20 | 20,11,20 | A08-00 | F( 1/10)T |
| 06/20 | 20,29,35 | B10-23 | P( 0/00)* |
| 06/28 | 17,53,24 | B10-24 | P( 0/00)* |
| 06/28 | 18,30,42 | C05-11 | LOGIN     |
| 06/28 | 20,17,47 | C05-12 | P( 0/00)* |
| 06/30 | 15,55,35 | A08-01 | F( 3/10)X |
| 06/30 | 17,11,47 | B13-25 | P( 0/00)* |
| 07/01 | 18,00,08 | A08-02 | F( 4/10)X |

FIGURE 8. SAMPLE LISTING OF THE LOG FILE.

\*\*\*\*\*  
KEY DISKETTE  
\*\*\*\*\*

- A ADD NEW NAMES TO GROUP FILE
- B BEGIN NEW LOG FILE, DESTROY OLD
- C CHANGE COMPANY NAME
- D DELETE NAMES FROM GROUP FILE
- P PRINT/DISPLAY GROUP OR LOG FILE
- Q QUIT
- R REVISE GROUP OR LOG FILE

SELECT A, B, C, D, P, Q, or R

THEN PRESS RETURN

FIGURE 9. THE KEY DISKETTE MAIN MENU LISTING THE VARIOUS FILE MANAGEMENT OPTIONS AVAILABLE TO THE FIELD INSTRUCTOR.

### Field Instructor Record Keeping

Besides the System Manager, the Field Instructor should keep his/her own records for each student. The following forms are samples of what might be used to facilitate this record keeping.

The first form is the Progress Chart. The Progress Chart summarizes the activity of the student to date. For each student, the completion date for each test, theory, lab, and skill module is recorded. See Figure 6.

### Field Instructor Schedule

Being accessible is very important to the student. Most of the work by the student will proceed without intervention by the Field Instructor. However, when there is a problem, the student must be able to get the needed assistance quickly.

If the need is not critical, e.g. question on a particular concept or lab activity, regularly scheduled times that the Field Instructor will be at the worksite will given the student opportunity to get the help needed.

If the need is critical, then the student should use the hot-line to get his question answered. The effectiveness of the hot-line will depend on the availability of a faculty member sufficiently versed in the use of the interactive-video materials to help the student. Hence, there is a need for the entire faculty to have some level of familiarity with the program and some to have indepth experience.

### Problem Report Form

The Problem Report Form is a way of documenting failues in either the hardware or software components of the worksite training materials. Extra forms should always be available at the student station and the Field Instructor should check for completed forms every time a visit to the worksite is made. To facilitate the submission of forms, a Field Instructor mailbox or basket should be provided at the student station. See Figure 7.

# PROGRESS CHART

| NAME | TYPE     | PROGRESS |  |  |  |  |  |  |  |
|------|----------|----------|--|--|--|--|--|--|--|
|      | Test     |          |  |  |  |  |  |  |  |
|      | Theory   |          |  |  |  |  |  |  |  |
|      | Lab Jobs |          |  |  |  |  |  |  |  |
|      | Skills   |          |  |  |  |  |  |  |  |
|      | Test     |          |  |  |  |  |  |  |  |
|      | Theory   |          |  |  |  |  |  |  |  |
|      | Lab Jobs |          |  |  |  |  |  |  |  |
|      | Skills   |          |  |  |  |  |  |  |  |
|      | Test     |          |  |  |  |  |  |  |  |
|      | Theory   |          |  |  |  |  |  |  |  |
|      | Lab Jobs |          |  |  |  |  |  |  |  |
|      | Skills   |          |  |  |  |  |  |  |  |
|      | Test     |          |  |  |  |  |  |  |  |
|      | Theory   |          |  |  |  |  |  |  |  |
|      | Lab Jobs |          |  |  |  |  |  |  |  |
|      | Skills   |          |  |  |  |  |  |  |  |
|      | Test     |          |  |  |  |  |  |  |  |
|      | Theory   |          |  |  |  |  |  |  |  |
|      | Lab Jobs |          |  |  |  |  |  |  |  |
|      | Skills   |          |  |  |  |  |  |  |  |
|      | Test     |          |  |  |  |  |  |  |  |
|      | Theory   |          |  |  |  |  |  |  |  |
|      | Lab Jobs |          |  |  |  |  |  |  |  |
|      | Skills   |          |  |  |  |  |  |  |  |

## PROBLEM REPORT FORM

LOCATION \_\_\_\_\_ STATION # \_\_\_\_\_  
 NAME \_\_\_\_\_ DATE \_\_\_\_\_ TIME \_\_\_\_\_

## PROBLEM AREA:

|                                          |                                       |
|------------------------------------------|---------------------------------------|
| <input type="checkbox"/> Homework Review | <input type="checkbox"/> Lab Jobs     |
| <input type="checkbox"/> Pre-Test        | <input type="checkbox"/> Post-Test    |
| <input type="checkbox"/> Theory Tape     | <input type="checkbox"/> Skill Module |

## Problem Description:

## ACTION TAKEN:

|                                            |                                       |
|--------------------------------------------|---------------------------------------|
| <input type="checkbox"/> Restarted Program | <input type="checkbox"/> On-Site Help |
| <input type="checkbox"/> Field Instr. Help | <input type="checkbox"/> Gave Up      |
| <input type="checkbox"/> Hot-Line          | <input type="checkbox"/> Left Note    |
| <input type="checkbox"/> Other             |                                       |

COMMENTS: \_\_\_\_\_  
 \_\_\_\_\_

## SUMMARY:

## Equipment Failure:

☐ Apple  
☐ Whitney  
☐ Test Equipment:  
☐ Disk Drive  
☐ Clock Card  
☐ Video Program

## Instructional Materials:

☐ Diskette  
☐ Videotape  
☐ Software  
☐ Supplies

Description: \_\_\_\_\_

ACTION TAKEN: \_\_\_\_\_ DATE \_\_\_\_\_

Interactive-video instruction does offer an alternative mode of instruction for those individuals who, for one reason or another, cannot avail themselves of traditional on-campus courses. Courseware is now available for DC electronics, AC electronics, and semiconductor principles interactive-video-based courses.

The courseware is designed to run on an Apple Computer/Sony Betamax videotape system. Additional electronic instruments, supplies, and special lab set-ups are needed to fully equip a student station. The cost of a student station is approximately \$10,000.

The software cost is \$10,000 for the first copy of a course. Subsequent copies cost \$5,000. Each copy consists of approximately forty videotapes and seventy diskettes. One course copy will support multiple student stations since no two or three students will require the same diskette and videotape at any given point in time.

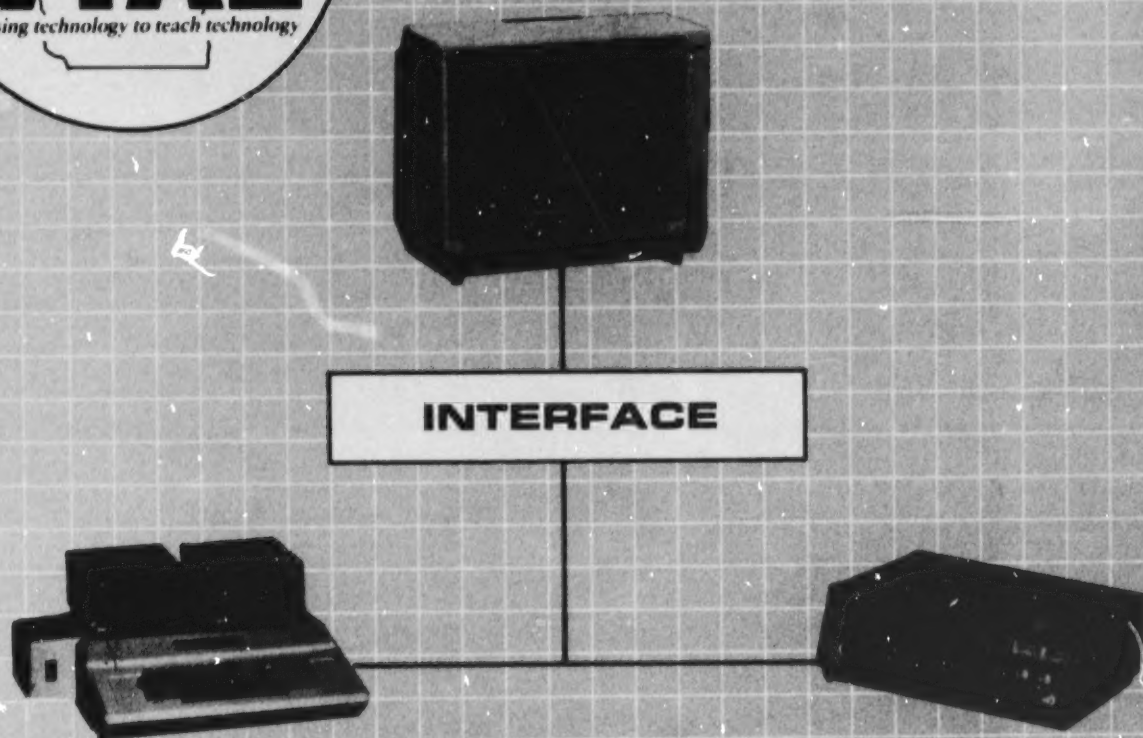
Although the course is self-paced and individualized, the crucial element in the entire system is the field instructor. The role of the field instructor is to manage the learning process. Initially the field instructor role is instructional, working with the student on the operation of the computer-videotape player system and the instructional materials. Later, the field instructor becomes the encourager, troubleshooter, and record keeper.

In summary, interactive-video instruction is providing that electronics instruction can be offered in a self-paced, individualized, open-entry/open-exit format.

For further information on the various uses for interactive-video system for teaching electronics, contact the Wisconsin Foundation for Vocational, Technical and Adult Education, Inc., 5402 Mineral Point Road, Madison, WI 53705. Telephone: (608) 231 - 3626.



## APPENDICES



# ELECTRONICS TRAINING VIA INTERACTIVE COMPUTER/VIDEO

*The Wisconsin Foundation for Vocational, Technical and Adult Education, Inc.*



- The Wisconsin Foundation for Vocational, Technical and Adult Education, Inc. is involved in the development and distribution of a software package for teaching electronics by way of a sophisticated interactive computer/video learning system.
- The interactive learning system offers trainers and educators options for implementing open entry/open exit, self-paced, individualized, competency-based, computer-managed training programs.
- Software for DC and AC Electronics has been completed and is currently available for purchase.
- Semiconductor Devices is in production and will be released in June of 1984.
- Digital Techniques is in the planning stages and should be released in mid-1985.
- The production of a microprocessor course is being considered as the next course after Digital Techniques.
- The software is designed to work with a Whitney Interface Card.
- Major components of the interactive learning system include: Apple microcomputer, two disk drives, color monitor, Sony Beta I videoplayer and electronics laboratory testing equipment.
- The software for DC and AC Electronics was first field-tested with great success in the Silicon Valley area of California.
- Major industries using this electronics training system include: Ampex, AML, Apple, Farinon, Hewlett-Packard, Litton, Savin, Siltec and Texaco.
- Colleges using the system include: Waukesha County Technical Institute, Wisconsin; Hutchinson Area Vocational-Technical Institute, Minnesota; Seneca College, Ontario; Los Angeles Community College District and the College of San Mateo, California.
- A very special use of this interactive system is being pioneered in a Michigan correctional facility, where inmates are receiving quality electronics training.

## WHY INTERACTIVE VIDEO?

The availability of microcomputers in education and training has provided the opportunity for more widespread use of Computer Assisted Instruction. This technology has helped the efforts of educators and trainers to create self-paced, individualized instruction.

Developments in the video field have also enhanced such efforts and competency-based video courses are now well-accepted in many educational and training programs. The logical next step was to marry the microcomputer and the videoplayer in order to maximize the teaching effectiveness of both technologies.

Interactive computer/video learning systems continue to provide competency-based, individualized, self-paced

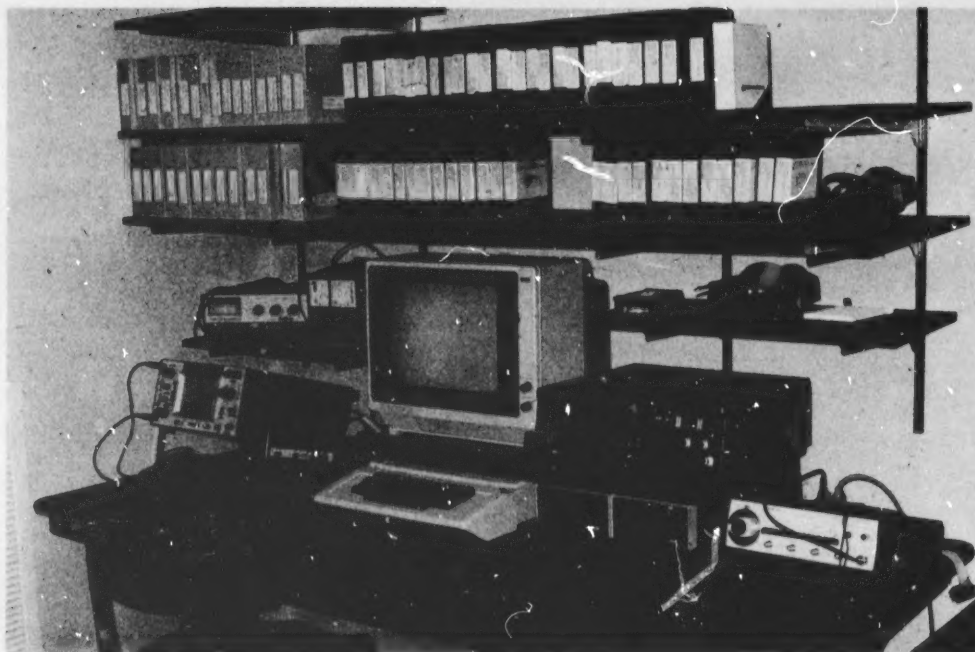
instructional opportunities. Interactive systems, however, enhance conventional CAI systems by adding the power of the videotaped demonstration. And interactive systems improve upon regular video courses by eliminating the passivity of the students' learning experience. Furthermore, the use of a microcomputer in an interactive video system allows the entire instructional process to be computer-managed.

Interactive computer/video learning systems have indeed given users of conventional CAI and regular video courses the opportunity to take the next step toward improving education and training opportunities.

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## BACKGROUND

During the past several years, the major focus of the Wisconsin Foundation for Vocational, Technical and Adult Education, Inc. has been the production and acquisition of video-based instructional materials with the objectives of: 1) better serving distance learners through broadcast and cable television offerings; and 2) better serving the training needs of business and industry by offering on-site video courses through local colleges. The Foundation's greatest success has been with the use of a linear video series called "Basic Electricity and AC-DC Circuits." Several states have adopted the series for systemwide use and numerous television stations, colleges and industries across the nation are successfully using the AC-DC series.

Recently, the Foundation entered into an agreement with the College of San Mateo to develop and distribute a complete electronics interactive training package. Staff members in the Electronics Department at San Mateo began development by adapting the theory portions of the AC-DC video series and making them interactive. They then produced additional interactive video and computer programs. The system is competency-based, individualized, self-paced, open entry/open exit, computer-managed and requires active student participation.

## HOW THE SYSTEM WORKS

All the required software, lab equipment, computer, video player and monitor are arranged in the learning station, creating a pleasant work environment. In some cases, a telephone is provided, which allows the trainee direct access to an instructor for purposes of technical troubleshooting and consultation on content difficulties.

Trainees are guided through the course by following the structured student manual. The course is divided into modules. For each module there is a separate box of diskettes and students are referred to the correct corresponding videotapes. Each module can include up to five different types of activities, but may include only some of them, depending on content requirements. The five activities are:

### Homework Review

No videotape is used for this activity. The trainee simply loads the review diskette and answers the questions on the previous homework assignment. This is done mainly to refresh the trainee's memory and to indicate whether he/she is, in fact, ready to begin the module.

### Pre/Post Test

No videotape is used for this activity. Trainees may feel that their previous knowledge and experience make it unnecessary for them to proceed through a particular module. They are free to test out of the module by passing the Pre Test. If trainees do work through the module, they must pass the Post Test before moving on to the next module. Pre/Post Tests include about 10-12 questions, which are randomly generated from a bank of approximately 125 questions.

### Theory Lessons

Almost all of the modules include at least one theory lesson, providing the required understanding to complete the laboratory applications. Trainees load the theory videotape and the corresponding diskette and proceed to work through the lesson. The Apple controls the VCR, showing only 2-3 minute segments of video, which are ended either by computer-generated directives or by a question(s). Trainees cannot advance to the next segment of video before correctly answering the question(s) at the end of the previous segment. Wrong answers automatically activate the system to provide a video review segment. Right answers are acknowledged by a friendly computer-generated pat-on-the-back.

All of the interactive videotapes can be paused by pressing the space bar. Pressing the "H" key stops the videotape and provides the following choices: 1. Rewind 20 seconds; 2. Fast forward to the next stop; 3. Return to Menu; 4. Quit now; 5. Continue.

### **Skill Modules**

The skill modules are usually brief interactive video lessons, which sharpen specific skills needed to complete laboratory applications. For example, one of the skill modules is on the basic operation of an oscilloscope. Trainees are guided through the procedures for setting up and operating an oscilloscope by means of an interactive hands-on experience.

### **Lab Jobs**

The interactive lab jobs are perhaps the most powerful learning tool in the system. Lab experiments are carefully explained on video and trainees are given specific instructions for setting up equipment, making correct

connections and setting appropriate dials. Trainees feed readings and measurements into the Apple at relevant intervals, so that the computer can check progress throughout the experiment. Once again, the computer will not allow the trainee to advance to the next phase of the experiment until all previous procedures have been correctly executed.

### **The System Manager**

The "System Manager" diskette is loaded in the second disk drive at all times. Its purpose is to keep accurate records of the trainee's performance. Trainees enter their Identification Number before beginning any activity. The computer checks the I.D. to establish whether or not the trainee has permission to work on a particular activity. The "System Manager" records the time and date the trainee began and ended an activity and also keeps accurate test scores. At any point, the course manager (instructor) can get a printout to review the trainee's progress and performance.





# COURSE OUTLINES

The following four course outlines include all of the subjects covered in each module. In parentheses after each title, lessons are designated as Theory, Lab Job or Skill Module. For each of these interactive video lessons, one diskette and one videotape is provided. Also included in each module, but not repetitively specified in the outline below, is a Pre/Post Test and an Active Homework Review diskette.

## DC ELECTRONICS

### I. PRINT MATERIALS

- a) Text: *DC Electronics* (Heath EB-6101)
- b) DC Student Manual with materials for each Module

### II. LESSON MODULES

#### MODULE ONE: *Matter and Charges*

- "Apple Hand Shake" (Miscellaneous diskette)

#### MODULE TWO: *Current Flow and Circuits*

- "Prefixes" (Miscellaneous diskette)
- "Scientific Notation and Metric Prefixes" (Theory)
- "Volts, Amps, Ohms, Watts" (Skill Module)

#### MODULE THREE: *Electromotive Force*

- "Electromotive Force" (Theory)
- "The Voltmeter" (Theory)
- "Meter Scales" (Skill Module)
- "The Analog Multimeter" (Skill Module)
- "The Digital Multimeter" (Skill Module)
- "Measuring Voltage" (Lab Job)

#### MODULE FOUR: *Batteries and Voltage Drops*

- "Voltage Rises and Voltage Drops" (Theory)
- "The Calculator—Getting Started" (Skill Module)

#### MODULE FIVE: *Resistance*

- "Color Code Disk" (Miscellaneous diskette)
- "Resistance" (Theory)
- "Series Parallel Resistive Circuits" (Theory)
- "The Ohmmeter" (Theory)
- "The Calculator: Prefixes and Resistance Problems" (Skill Module)
- "Measuring Resistance" (Lab Job)
- "Using the Lab Breadboard" (Lab Job)
- "Continuity, Opens and Shorts" (Lab Job)
- "Measuring Resistance Characteristics" (Lab Job)

#### MODULE SIX: *Ohm's Law and Power*

- "Ohm's Law and Power" (Theory)
- "The Calculator: Prefixes and Ohm's Law Problems" (Skill Module)

- "Verifying Ohm's Law" (Lab Job)
- "Power" (Lab Job)

#### MODULE SEVEN: *Magnetism*

- "Magnetism" (Theory)
- "AC and DC Generators" (Theory)
- "Electromagnetism" (Lab Job)
- "Magnetic and Electromagnetic Devices" (Lab Job)

#### MODULE EIGHT: *Current and Ammeters*

- "The Ammeter" (Theory)
- "Measuring Current" (Lab Job)

#### MODULE NINE: *Voltmeters and Ohmmeters*

- "The Multimeter" (Theory)
- "Loading Effects of Voltmeters" (Lab Job)

#### MODULE TEN: *Series, Parallel and Voltage Divider Circuits*

- "Series-Parallel Resistive Circuits" (Theory)
- "Voltage Dividers" (Theory)

#### MODULE ELEVEN: *Circuit Analysis*

- "Kirchhoff's Law" (Theory)
- "Superposition/Network Theorems" (Theory)
- "Resistance Bridge Circuits" (Lab Job)

#### MODULE TWELVE: *Thevenin's and Norton's Theorems*

- "Superposition/Network Theorems" (Theory)

#### MODULE THIRTEEN: *Inductance and Capacitance*

- "Inductors and Capacitors" (Theory)

#### MODULE FOURTEEN: *Capacitive Circuits*

- "RC and LR Time Constants" (Theory)
- "RC Time Constants" (Lab Job)
- "Capacitors in Series and Parallel" (Lab Job)
- "Using Capacitors" (Lab Job)

## AC ELECTRONICS

### I. PRINT MATERIALS

- a) Text: *AC Electronics* (Heath EB-6102)
- b) AC Student Manual with materials for each module

### II. LESSON MODULES

MODULE ONE: *Introduction to Alternating Current*

- "Introduction to Alternating Current" (Theory)

MODULE TWO: *The Sine Wave and AC Values*

- "Characteristics of the Sine Wave" (Theory)
- "Measuring AC Voltage" (Lab Job)

MODULE THREE: *AC Measurements*

- "Oscilloscopes" (Theory)
- "The Oscilloscope: Basic Operation" (Skill Module)
- "The Oscilloscope: Determining Period and Frequency" (Skill Module)

MODULE FOUR: *Resistive Circuits and Introduction to Capacitors*

- "AC Resistive Circuits and Introduction to Capacitors" (Theory)

MODULE FIVE: *Capacitive Circuits*

- "Capacitive AC Circuits" (Theory)
- "Capacitive Reactance and Impedance" (Lab Job)

MODULE SIX: *Math Applications in AC Circuits*

- "Math Applications" (Theory)

MODULE SEVEN: *Inductive Circuits*

- "Introduction to Inductors" (Theory)
- "Inductive Reactance and Impedance" (Lab Job)

MODULE EIGHT: *RL Circuits*

- "Inductive AC Circuits" (Theory)
- "Dual Trace Oscilloscope—Measuring Voltage" (Lab Job)
- "Dual Trace Oscilloscope—Measuring Phase Shift" (Lab Job)

MODULE NINE: *Transformer Theory*

- "Transformers I" (Theory)
- "Measuring Transformer Characteristics" (Lab Job)

MODULE TEN: *Transformer Applications*

- "Transformers II" (Theory)
- "Transformer Loading Effects" (Lab Job)
- "Transformers In-Phase and Out-of-Phase" (Lab Job)

MODULE ELEVEN: *RLC Circuits*

- "RLC Circuits and Introduction to Resonance" (Theory)

MODULE TWELVE: *Series Resonance*

- "Series Resonance/Parallel Resonance" (Theory)
- "Series Resonance and Bandwidth Measurement" (Lab Job)

MODULE THIRTEEN: *Parallel Resonance and Filters*

- "Series Resonance/Parallel Resonance" (Theory)
- "Parallel Resonance" (Lab Job)
- "Band-Pass and Band-Stop Filters" (Lab Job)
- "Low-Pass and High-Pass Filters" (Lab Job)

## SEMICONDUCTOR DEVICES

The following is a tentative outline for the Semiconductor Devices course, which should be released at the end of 1983.

### I. PRINT MATERIALS

- a) Text: *Semiconductor Devices* (Heath)
- b) Student Manual with materials for each module.

### II. LESSON MODULES

MODULE ONE: *Semiconductor Fundamentals*

- "Semiconductors" (Theory)
- "Identifying Ohmmeter Lead Polarity" (Lab Job)

MODULE TWO: *Conventional Silicon Diode*

- "The Silicon Diode" (Theory)
- "Diode Anode/Cathode Lead Identification" (Lab Job)
- "Half-wave Rectifier Circuit" (Lab Job)



#### MODULE THREE: *Zener Diode*

- "Characteristics of a Zener Diode" (Lab Job)
- "Zener Diode Voltage Regulator" (Lab Job)

#### MODULE FOUR: *Special Purpose Diodes*

- "Tunnel Diode" (Theory)

#### MODULE FIVE: *Bipolar Junction Transistor Action*

- "The Bipolar Transistor" (Theory)
- "Using an Ohmmeter to Check the Bipolar Transistor" (Lab Job)
- "Common-Emitter Voltage Amplifier" (Lab Job)

#### MODULE SIX: *Bipolar Junction Transistor Characteristics*

- "Testing Common-Emitter Characteristics In-Circuit" (Lab Job)

#### MODULE SEVEN: *Unipolar Junction Field Effect Transistors*

- "The Junction FET" (Theory)
- "Using an Ohmmeter to Check the Junction FET" (Lab Job)
- "Testing Common Source Characteristics In-Circuit" (Lab Job)

#### MODULE EIGHT: *FET and MOSFET Circuit Configurations*

- "Common-Source Voltage Amplifier" (Lab Job)

#### MODULE NINE: *Thyristors*

- "Testing SCR Characteristics" (Lab Job)

#### MODULE TEN: *Integrated Circuits*

- "The Operational Amplifier" (Lab Job)

#### MODULE ELEVEN: *Optoelectronic Devices*

- "Phototransistor Characteristics" (Lab Job)
- "LED Characteristics" (Lab Job)

## DIGITAL TECHNIQUES

The following is a tentative outline for the Digital Techniques course, which should be released in mid-1984.

### I. PRINT MATERIAL

- a) Text: *Digital Techniques* (Heath: Books 1 and 2)
- b) Student Manual with material for each module

### II. LESSON MODULES

#### MODULE ONE: *Introduction to Digital Techniques*

- "Introduction to Digital Electronics" (Theory)
- "Binary Nature of Digital Circuits" (Theory)

#### MODULE TWO: *Semiconductor Devices*

- "Basics of Transistors and ICs" (Theory)
- "Bipolar Transistor Switching Circuits" (Lab Job)

#### MODULE THREE: *Digital Logic Circuits*

- "Logic, Gates and Symbols" (Theory)
- "Logic Inverters, AND, and OR Gates" (Lab Job)

#### MODULE FOUR: *Digital Integrated Circuits*

- "Introduction to Digital IC Families" (Theory)
- "Modern Digital IC Families" (Theory)

#### MODULE FIVE: *Boolean Algebra*

- "Testing NAND, NOR, and OR Gates" (Lab Job)

#### MODULE SIX: *Flip-Flops*

- "Flip-Flops (part one)" (Theory)
- "Testing R-S and D-type Flip-Flops" (Lab Job)
- "Integrated Circuit and Clocked Latches" (Lab Job)

#### MODULE SEVEN: *Flip-Flops and Registers*

- "Flip-Flops (part two)" (Theory)
- "J-K Integrated Circuit Flip-Flops" (Lab Job)

#### MODULE EIGHT: *Sequential Logic Circuits and Counters*

- "Counters and Shift Registers" (Theory)
- "Testing Binary, Ring, Shift and BCD Counters" (Lab Job)

#### MODULE NINE: *Shift Registers and Clocks*

- "Operation of a Shift Register" (Lab Job)
- "Testing Astable and Monostable Circuits" (Lab Job)

#### MODULE TEN: *Combinational Logic Circuits*

- "Combinational Logic Circuits" (Theory)
- "Logic Functions and Multiplexer ICs" (Lab Job)

#### MODULE ELEVEN: *Combinational Logic Circuits* (cont.)

- "OR/NOR Gates and Parity Bit Conversion, Code Conversion and Magnitude Comparison" (Lab Job)

#### MODULE TWELVE: *Digital Design*

- "Random Gates and Multiplexers" (Lab Job)
- "Digital Die Circuits" (Lab Job)

#### MODULE THIRTEEN: *Digital Applications*

- Pre/Post Test
- Homework Review

## EQUIPMENT

The following equipment is needed for the successful operation of the interactive computer/video learning system:

1. Apple II or IIe (or equivalent)
2. Two Disk Drives
3. Color Monitor
4. Videotape Player (Sony SLP303, SLP305, SLO323, SLO325)
5. Whitney Interface Card
6. Mountain Computer Clock Card

**Note:** The software for this system was designed to be used with an Apple microcomputer, a Beta videotape player and a Whitney Interface Card. The software is not currently available for use with any other microcomputer. Customers wishing to use certain  $\frac{3}{4}$ " Sony U-MATIC videotape players should have no problems. Substantial investment of time and money would have to be made by customers wishing to use a different microcomputer and/or a VHS videotape player.

## LABORATORY HARDWARE

The following list includes the hardware needed to successfully complete the hands-on portions of all the four courses listed above. However, for the Semiconductor and Digital courses, additional items are required at a total cost of approximately \$500.

1. Frequency Counter (Heath SM-2410)
2. FET Multimeter (Heath SM-5225)
3. Digital Multimeter (Leader LDM-855)
4. Tri-Power Supply (Heath SP-2718)
5. Oscilloscope (Hitachi V-212)
6. Function Generator (HP3311A)
7. Calculator (HP-32E)
8. Headphones
9. Electronic Doorbell (Heath TD 1089)
10. Darkroom Timer (Heath PT 1500)
11. DC Parts Kit (Heath EB 6101-30)
12. AC Parts Kit (Heath EB 6102-30)
13. Supplementary Parts Kit
14. Jumper Wire Kit (22 GA)
15. Protoboard 101
16. Solder
17. Soldering Iron and Stand
18. Test Lead Set
19. Color Code Chart

**Note:** While the above items are recommended, since they are specifically shown in the videotapes, it is possible to substitute other similar items. Some instructors, in fact, prefer to substitute equipment, claiming that substitutions make students immediately aware of variation and insure that they are able to work with the wide variety of equipment encountered on the job.



# ACQUISITION OF SOFTWARE, EQUIPMENT AND LABORATORY HARDWARE

## 1. SOFTWARE

The Wisconsin Foundation for Vocational, Technical and Adult Education, Inc. is the national distributor for the electronics interactive computer/video software. The Foundation can also supply Whitney Interface Cards and Mountain Computer Clocks.

## 2. EQUIPMENT AND HARDWARE

Each work station should contain all of the equipment and hardware listed above. Work stations can be equipped at an estimated cost of \$12,000 per station. All the necessary items may be acquired from the most convenient and economical vendor. The Electronic Doorbell and Darkroom Timer are specially adapted and can be acquired through the Foundation.

The Foundation will also contract for complete turnkey systems, including: software, equipment, hardware, installation and in-servicing of training personnel.

# PRICE INFORMATION

## 1. PRINT MATERIALS

- DC Student Manual \$ 20.00
- AC Student Manual \$ 20.00
- DC and AC texts should be ordered from Heath

## 2. COMPUTER AUXILIARIES

- Whitney Interface Card \$ 695.00
- Mountain Computer Clock \$ 250.00

## 3. SOFTWARE

A. DC Electronics (includes 40 videotapes and 72 diskettes)

- First set of software @ \$10,000.00

B. AC Electronics (includes 27 videotapes and 53 diskettes)

- First set of software \$10,000.00

C. Semiconductor Devices (tentative price list)

- First set of software @ \$10,000.00

D. Digital Techniques (tentative price list)

- First set of software @ \$10,000.00

**Note:** All prices subject to change without notice. Discounts will be offered for multiple set purchases.

## PREVIEW INFORMATION

Staff at the Wisconsin Foundation for Vocational, Technical and Adult Education, Inc. would be pleased to discuss with you the various uses for the interactive computer/video system for teaching electronics. In order for you to become more familiar with the way the system works and to appreciate the high quality of the instruction, the Foundation provides a number of preview options. If you wish to explore your interest in using interactive electronics training, you may request a linear videotape which provides an overview of the system and/or a sample interactive lesson. To receive preview materials or for answers to your questions, contact:

Wisconsin Foundation for Vocational, Technical  
and Adult Education, Inc.  
5402 Mineral Point Road  
Madison, WI 53705  
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